MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

SUPPLEMENTARY EXAMINATION

TRIMESTER 1, 2015/2016

TCS3511 THEORY OF COMPUTING/ TIC2151 THEORY OF COMPUTATION/

(All sections / Groups)

18 NOV 2015
2.30 PM – 4.30 PM
(2 HOURS)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages only excluding the cover page.
2. Attempt All questions.All questions carry equal marks and the distribution of the marks for each question is given.
2. Please write your answers in the answer booklet provided. Please write the question number of each answer clearly.

QUESTION (1)

NOTE: Attempt any THREE out of FOUR Parts (A), (B), (C) and (D).

(A)

1. What is *automata theory*? (Give a precise definition) [2 marks]
2. Prove the following by construction: [3 marks]

"For any integers **a** and **b**, if **a** or **b** is even, then **ab** is even".

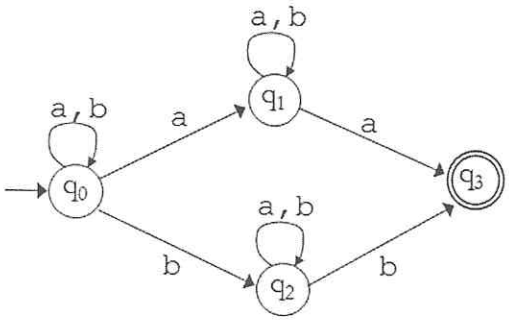
(B) Draw the state diagram of DFAs accepting each of the following languages:

$L_1 = \{w \in \{a\}^* \mid |w| = a^{4k+1}, k \geq 0\}$ [2.5 marks]

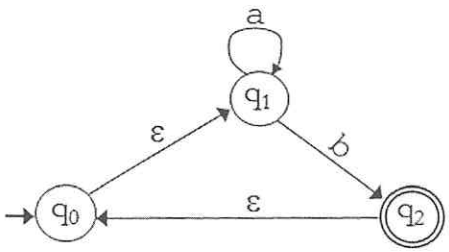
$L_2 = \{w \in \{a, b\}^* \mid w$ has neither aa nor bb as a substring$\}$. [2.5 marks]

(C)

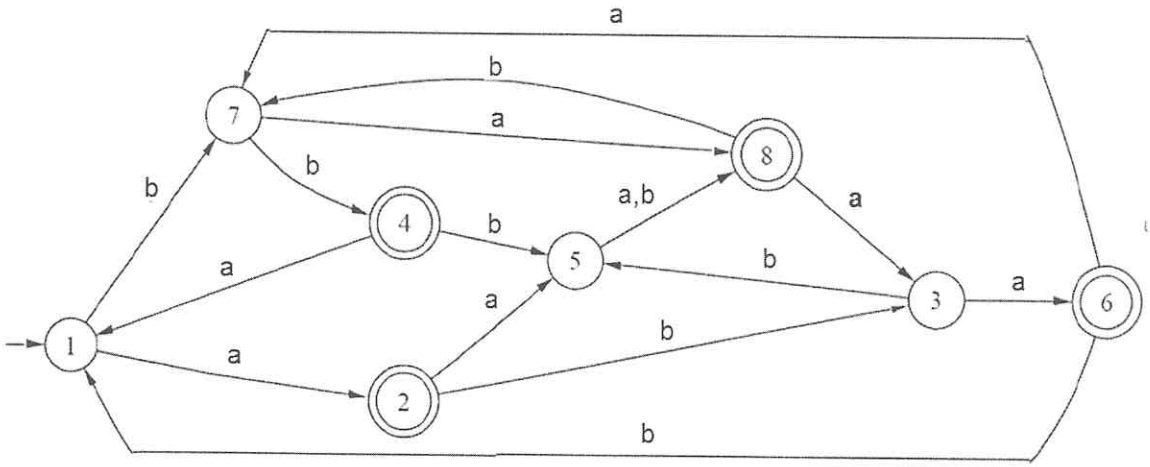
1. What is the language recognized by the following NFA? [2 marks]



2. Convert the following NFA into an NFA without ε-transition. Show the new table of transition and the corresponding state diagram. [3 marks]



(D) Minimize the following DFA. Show your steps.



QUESTION (2)

(A)

1. Determine the language corresponding to each of the following regular expressions:

   i. $((a + b)\ (a + b)\ (a + b))^*$ [1 mark]

   ii. $a(a + b)^+b + b(a + b)^+a$ [1 mark]

2. Find regular expressions corresponding to each of the following languages. [3 marks]

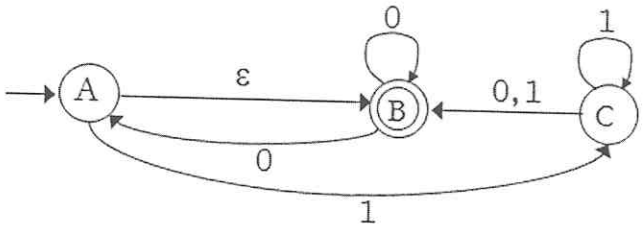
   i. L={ w∈{0, 1}* | String w is of even length}
   ii. L={ w∈{0, 1}* | w contains at most two 0's. }
   iii. L={ w∈{0, 1}* | String w contains no more than one occurrence of the string 00}.

(B) Convert the following regular expressions into an NFA. Follow the construction rules closely and do not just give a simpler NFA even though it is possible. [5 marks]

$(01)^*(0 + 1)^*0$

(C)

1) What is the regular grammar corresponding to the NFA given below?[2 marks]



2) Give the regular grammars corresponding to each of the following languages over the alphabet $\{a, b\}$.

   L_1 = {w | w contains at least two a's } [1.5 marks]
   L_2={ w | w contains the substring aa or bb} [1.5 marks]

QUESTION (3)

NOTE: Attempt any THREE out of FOUR Parts (A), (B), (C) and (D).

(A) Use the pumping lemma for regular languages theorem to prove that the following language is not regular.

$$L = \{0^n 1^n 2^n \mid n > 0\}$$ [5 marks]

(B) Construct a PDA for each of the following languages:

$L_1 = \{a^{n+m} b^m c^n \mid n, m >= 1\}$ [2.5 marks]

$L_2 = \{ wcw^R \mid w \in \{a, b\}^+ \}$. [2.5 marks]

(C) Give context-free grammars for each of the following languages

$L_1 = \{w \in \{0, 1\}^* \mid w$ starts and ends with the same symbol$\}$. [2.5 marks]

$L_2 = \{a^n b^m \mid m > n, m, n \geq 1\}$ [2.5 marks]

(D) Convert the following context-free grammar into Chomsky Normal Form (CNF). Show your main steps. [5 marks]

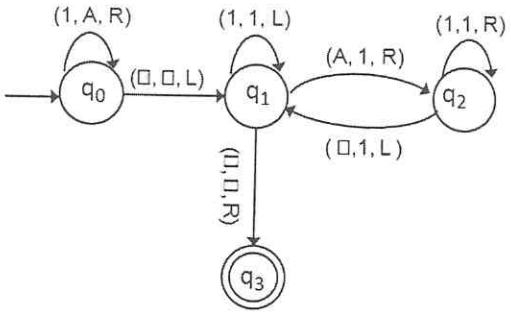
$S \rightarrow AB$
$A \rightarrow aAA \mid \varepsilon$
$B \rightarrow bBB \mid \varepsilon$

QUESTION (4)

(A)

1) What does the Turing Machine in the following figure do? [1.5 marks]

2) Give the formal definition of this Turing Machine including the transition table. [3.5 marks]



(B) Construct a Turing Machine for the language $L = \{a^n\ b\ a^m \mid 0 \leq n \leq m\}$. [5 marks]

(C)

1. What does it mean to say that a set S is countable? Explain briefly. [1.5 marks]
2. Briefly define *Turing-decidable* languages. [1.5 marks]

3. Given the following two languages:
   $A_{DFA} = \{\langle B, w\rangle \mid B \text{ is a DFA that accepts input string } w\}$.
   $A_{NFA} = \{\langle C, w\rangle \mid C \text{ is a NFA that accepts input string } w\}$.

A_{DFA} has been proved to be a decidable language. Prove that A_{NFA} is a decidable language as well. [2 marks]

End of page.